CHAPTER 7

North American Feebate Analysis Model

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Canadian automobile manufacturers and the Canadian government recently signed an agreement to reduce greenhouse gas (GHG) emissions from passenger cars and light trucks by 5.3 megatonnes (MT) in 2010. The agreement is a key component of Canada's plan to meet its commitments under the international Kyoto Protocol. In 2003, transportation accounted for 25.7 percent of GHG emissions in Canada (Environment Canada, 2004), and this is expected to grow to 27.0 percent by 2020 (Natural Resources Canada, 1999). Seventy percent of transportation emissions are allocated to passenger transportation, a sector where emissions continue to grow.

If the current voluntary approach to mitigating passenger transportation emissions is not effective, one of the options to mitigate emissions would be to use economic instruments to provide an incentive for the purchase of fuel-efficient vehicles as a potential alternative or complement to regulation. Feebates are one possible economic instrument that could be established as a cost effective-way to curb GHG emissions from new light-duty vehicles (LDVs). Feebates are a market-based system in which every vehicle is either subject to a fee or rebate when purchased, depending on its fuel economy.

This chapter presents the results of recent analyses of financial incentives for fuel-efficient vehicles using a model of the North American vehicle market. It focuses mostly on the impacts of feebate policies implemented solely in Canada on the North American vehicle market. Successful implementation of a Canadian feebate system might induce some states in the United States to adopt similar systems and could possibly lead to a harmonized North American feebate policy. The potential gains in efficiency and the effectiveness of greater harmonization are explored.

Over the longer term, widespread use of advanced technologies offers perhaps the best potential for significant reductions in transport-related emissions, including GHG emissions. However, the progress of technological change is often slow and entails many stages. It is possible to mandate changes, but regulatory standards need to be frequently tightened to create a sustained incentive for fuel economy improvement. Market-based instruments, such as increased vehicle or fuel prices, cannot only be a powerful driver of change, but they can also provide a sustained incentive for the market to adopt advances in energy efficient technology.

In a recent analysis of feebates for the United States, Greene et al. (2005) concluded that feebates could effectively correct an imperfect market for fuel economy in which consumers appear to undervalue the discounted fuel savings over the full lifetime of a vehicle. That study found that a well-designed feebate policy could induce an economically efficient level of fuel economy with relatively little cost.

Like other studies of feebates for the U.S. market, Greene et al. found that the overwhelming majority of fuel economy improvements brought about by feebate policies, 90 percent or more, would be a result of the adoption of energy efficient technologies and efficient vehicle designs. Only 10 percent or less would be due to a shift in sales toward higher fuel economy makes and models. However, the Canadian market is smaller than the U.S. market and a feebate policy in Canada alone would have much less leverage for inducing manufacturers to adopt fuel economy technologies. Implementing a full-scale feebate program solely in Canada raises new questions about the costs to producers and consumers, as well as the effectiveness in increasing fuel economy.

The analysis conducted so far in Canada indicates that feebates could be designed to be an environmentally effective and economically efficient way to reduce GHG emissions from the transportation sector. However, these conclusions are only valid if the assumptions underlying the analysis are correct. In particular, great uncertainty remains due to poor knowledge of Canadian new vehicle price elasticities and perceived value of fuel savings. There are also knowledge gaps related to the impact of feebates on the used vehicle market. For instance, feebates might induce owners of vehicles subject to a fee to keep their vehicles on the road marginally longer or induce prospective buyers to try to avoid the fee by importing nearly new vehicles from markets where no feebate is imposed. Finally, this study did not consider how a feebate program would be implemented. Thus, the current analysis could not support the immediate implementation of a feebate program without first addressing these issues.

Analyzing Feebates in the North American Market

Although there have been previous analyses of feebate systems for the United States (e.g., Davis et al., 1995, and Greene et al., 2005) and Canada (e.g., HLB, 1999), only HLB Decision Economics, Inc., a consulting company with offices throughout North America, analyzed the potential effectiveness of a feebate system that applied solely to the Canadian vehicle market. This analysis was conducted by HLB in 1999 for the Canadian government in support of the National Climate Change Table process. The effect of a feebate policy in Canada is most appropriately represented as a change in the North American market demand for fuel economy. The task is to represent how manufacturers will respond when demand for fuel economy in the Canadian market increases, while demand in the U.S. market remains unchanged. This calls for two modifications of the single market model of Greene et al. First, Canadian and U.S. motor vehicle demand must be represented separately so that a feebate system can be imposed in one market without affecting demand in the other. Second, decision criteria must be specified for manufacturers to use in deciding whether or not to redesign a vehicle in response to the change in Canadian demand for fuel economy.

The separation of U.S. and Canadian markets was accomplished by first developing separate vehicle sales and attributes databases for the United States and Canada. Country-specific nested multinominal logit (NMNL) choice models were calibrated to the two databases (Train, 1986). Manufacturers were assumed to redesign a vehicle specifically for the Canadian market, if the sales of that vehicle in Canada exceeded a minimum level necessary to achieve scale economies in production.

When a vehicle sold in both markets did not have sufficient Canadian sales to justify redesign only for sale in Canada, a manufacturer was assumed to design a single vehicle for both markets, taking into consideration the increased demand for fuel economy in Canada. Since a feebate system will induce some increase in demand for fuel economy relative to the no-policy case, manufacturers will choose some increase in fuel economy but not nearly as much as if the feebate system applied in both markets. Domestic models lacking adequate sales in the combined North American market are not redesigned. Imports even with low-volume sales are redesigned to simulate a foreign manufacturer's option to substitute a different European or Asian design with higher fuel economy.

Structure of the North American Feebate Analysis Model

Like the U.S. feebate model of Greene et al., the North American Feebate Analysis Model (NAFAM), used to produce the analysis in this chapter, assumes that manufacturers will implement fuel economy technology on vehicles in a way that maximizes consumer satisfaction. Customer satisfaction is represented by consumer's surplus, the economist's monetary measure of well being. The consumer's surplus can be expressed as the difference between the total satisfaction a consumer obtains from the attributes of a new vehicle (hence, the maximum price he would be willing to pay) and the total price the consumer has to pay. Hence, the total utility of a new vehicle is the price paid plus the consumer's surplus.

Decision variables facing manufacturers are the fractional changes in fuel economy for every LDV sold in North America. Choosing a change in fuel economy affects consumer satisfaction in three ways: it provides fuel savings, it increases vehicle purchase price, and it reduces the fee or increases the rebate applicable to the vehicle in question.

Although there are many possible forms of feebates (Davis et al., 1995), the simplest and perhaps most interesting is a constant dollar rate per liter per 100 kilometers (L/100 km) of fuel consumption. This formulation values each liter of fuel saved at the same amount, regardless of which vehicle consumes the fuel. It assumes only that all vehicles are driven the same number of kilometers (km) per year. A single pivot point can be specified for all LDVs, or different pivot points can be assigned to different vehicle classes. This form of feebate is illustrated in the equation below for a vehicle model $_i$ in class $_j$ by a rate, R, and a pivot point, C', that determines the fuel consumption number above which a fee must be paid and below which a rebate is received. This formulation implies that fees will be negative and rebates positive.

$$F = R(C'_j - C_{ij})$$

The utility a consumer derives from a particular vehicle is assumed to be a function of its attributes. Among these attributes are purchase price and fuel economy. For purposes of the feebate analysis, it is assumed that all attributes except price, fee or rebate, and fuel economy are constant at the base year levels. Consumers are assumed to value fuel economy increases according to their perception of the value of fuel that will be saved as they use the vehicle. Perfectly rational consumers would measure this by the expected discounted present value of fuel saved over the full life of the vehicle. There is evidence that consumers do not actually make such assessments (Turrentine and Kurani, 2005). The NRC (2002) fuel economy study considered two alternatives for valuing fuel savings: full lifetime discounted present value fuel savings and a three-year simple payback. The same two conventions are used here.

The ability of manufacturers to supply fuel economy is represented by fuel economy technology cost curves. Curves describing the total cost of fractional improvements in fuel economy from a base level can be constructed from data on specific technologies, their costs and impacts on fuel economy (Greene and DeCicco, 2000). Cost is measured in terms of retail price equivalent, an estimate of the incremental price the purchaser of a car would pay based on fully burdened manufacturing costs plus manufacturer's profit and retailing cost and profit. Manufacturers are assumed to choose the fractional increases in fuel economy that maximize the total change in consumers' surplus for each vehicle, subject to whatever feebate policy may be in place.

Two alternative sources of fuel economy cost information were used in this study. The National Research Council (NRC, 2002) study produced three fuel economy cost curves—optimistic, average, and pessimistic—for four classes of passenger cars and six types of light trucks. The NRC average curves are used in this study. The NRC fuel economy cost curves do not distinguish between cars produced in North America and imported vehicles. A Transport Canada study conducted by the U.S. consulting firm EEA, Inc., provided data from which cost curves can be estimated for imported and North American–manufactured small cars, large cars, compact trucks and standard trucks (EEA, Inc., 2005). The EEA fuel economy cost curves have the added advantage of being calibrated to the year 2003, the same year as the sales and base fuel economy data used. Therefore, they are used for the majority of the policy cases presented in this study.

Canadian and U.S. Light-Duty Vehicle Markets

Some background on the distinctions between the Canadian and U.S. LDV markets is needed in order to understand the effect of feebates in the North American market and to identify implementation strategies. In North America, approximately 17.2 million LDVs with a gross vehicle weight rating of less than 3,856 kilograms (kg) were sold in 2003. Most of these vehicles, roughly 15.7 million, were sold in the United States. Table 7-1

TABLE 7-1. Light-Duty Vehicle Sales Market Shares—2003

	Canada	*U.S.*
Passenger Cars	56.5%	50.6%
Subcompact	7.7%	6.9%
Compact	31.4%	20.6%
Midsize	13.5%	16.9%
Large	3.9%	6.2%
Light Trucks	43.5%	49.4%
Small SUV	2.7%	2.8%
Medium SUV	13.9%	18.7%
Large SUV	1.0%	6.0%
Minivan	14.8%	6.4%
Large Van	1.2%	0.7%
Small Pickup	3.4%	5.1%
Large Pickup	6.4%	9.7%

Source: K.G. Duleep, Energy and Environmental Analysis Inc. Based on U.S. sales data coming from the National Highway Traffic Safety Administration's fuel economy database and on Canadian sales data coming from Transport Canada's Vehicle Fuel Economy Information System.

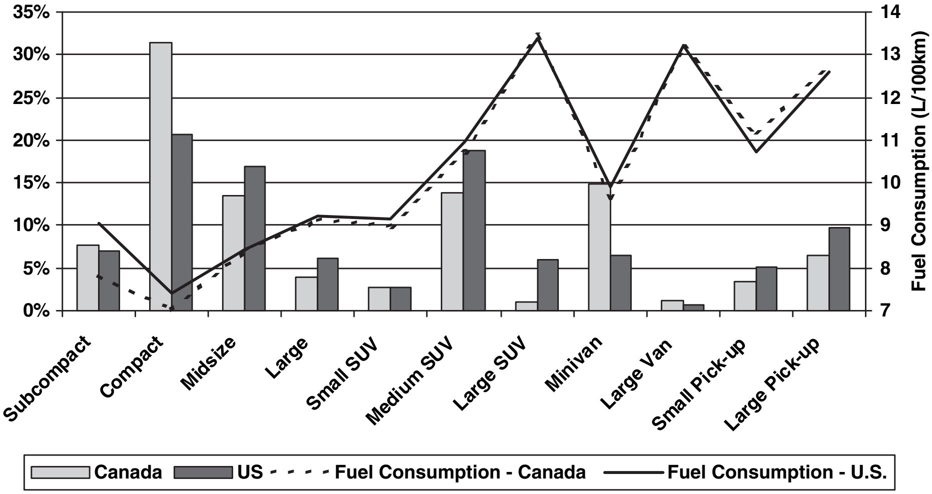

FIGURE 7-1. Average fuel consumption and vehicle sales by class—2003. *Source:* K. G. Duleep, Energy and Environmental Analysis Inc. Based on U.S. sales data coming from the National Highway Traffic Safety Administration's fuel economy database and on Canadian sales data coming from Transport Canada's Vehicle Fuel Economy Information System.

shows the distribution of sales in Canada and the United States among LDV categories. Overall, about 51 percent of North American LDV sales were cars, 27 percent sport utility vehicles (SUVs), 14 percent pickup trucks, and 8 percent vans/minivans.

There are major similarities between the U.S. and Canadian markets, particularly in the range of LDV models for sale. However, there are also some differences in choices of models and classes. Figure 7-1 shows Canadian and U.S. sales further disaggregated into vehicle size classes, using a market distinction based on the interior volume for cars and gross vehicle weight rating for light trucks. These distinctions are similar to U.S. Environmental Protection Agency size classes but customized for the development of the NRC fuel economy cost curves. Compact cars, minivans, and midsize SUVs—with 31 percent, 15 percent, and 14 percent of total sales, respectively—are especially attractive to Canadian vehicle purchasers, while compact cars, midsize cars, and SUVs are the most popular vehicles in the United States, with 21 percent, 17 percent, and 19 percent of total sales, respectively. Compact vans and minivans are relatively more popular in Canada, while in the United States, larger vehicles such as mid- and large-size cars, medium and large SUVs, and pickup trucks are more popular.

The average fuel consumption for all 2003 model year LDVs sold was 9.0 L/100 km in Canada and 9.8 L/100 km in the United States, but consumption among the 11 classes differed substantially in both countries. The full range in Canada and the United States varied from 3.2 to 22.0 L/100 km. Figure 7-1 further illustrates the variability of average fuel consumption, both between countries and vehicle classes.

Despite substantial adoption of technologies capable of increasing energy efficiency, fuel consumption for LDVs in both countries remained relatively stable between 1990 and 2003 as consumers increasingly favored greater performance and weight over saving gasoline. Between 1990 and 2003, the fuel consumption of the average car improved by about 6 percent in Canada, from 8.2 to 7.6 L/100 km. However, during the same period the average fuel consumption for LDVs sold in the United States increased by 4 percent, from 9.3 to 9.7 L/100 km.

Canadian and U.S. fuel economy standards have not significantly changed in recent years. The Canadian Corporate Average Fuel Consumption (CAFC) standards for LDVs have tracked the U.S. Corporate Average Fuel Economy (CAFE) standards for many years. As in the United States, Canadian standards differ for cars and light trucks, defined as all classes of SUV, vans, and pickup trucks. In 2003, the CAFC standards were 8.6 L/100 km for cars and 11.4 L/100 km for light trucks. Fleet average fuel consumption in 2003 was substantially below these values, at 7.6 L/100 km for cars and 10.7 L/100 km for light trucks.

The 5.3 MT reduction in GHG emissions called for by the Canadian industry/government voluntary agreement is roughly equivalent to improving fuel consumption to 7.4 L/100 km for all light-duty vehicles. This goal will be useful in comparing the environmental effectiveness of various feebate policy options.

Manufacturer and Consumer Decision Making

A key variable in the NAFAM analysis is the degree to which North American manufacturers and importers to the North American market will add fuel economy technologies to vehicles in response to a Canadian feebate policy. Although the NAFAM represents country-specific vehicle demand, vehicle manufacturers typically design one configuration of each make to sell in both countries in order to achieve economies of scale. The NAFAM simulates economies of scale by specifying sales thresholds over which a vehicle will be redesigned in response to a feebate and below which it will not. These thresholds were set at different levels for domestic and import vehicles. In the case of vehicles built in North America, sales must be above 20,000 units in Canada in order for manufacturers to consider a redesign in response to a Canadian feebate program.

For imported vehicles, Canadian sales must be above 2,000 units in order for manufacturers to consider a redesign in response to a Canadian feebate program. Although one of the key assumptions of the NAFAM is that no LDVs are introduced or removed from the market, the lower threshold for import vehicles reflects the fact that import manufacturers might

TABLE 7-2. NAFAM—Country-Specific Assumptions

	Canada	*U.S.*
Fuel Price (CAN¢/L)	80.0	47.6
Fuel Price (US$/gal)	2.51	1.50
Vehicle Lifetime (years)		
Cars	15	16.9
Light Trucks	15	15.5
New Vehicle Distance Traveled (km/yr)	23,500	25,106
Annual Rate of Decline	4%	4%
Discount Rate	10%	6%

choose to respond to the feebate by substituting a more fuel efficient design already being sold in another market, thereby avoiding the problem of scale economies.

Diesel-powered vehicles and hybrid electric vehicles were excluded from the feebate analysis. Only changes in the sales mix affect those vehicles, and only those makes and models offered in 2003 are included in the market analysis.

A number of assumptions from Greene et al. were also carried over to the NAFAM. In particular, both models use the same market share price elasticities:

- –10 for make and model choices within a class at a market share of 1.5 percent
- –5 for the choice among classes at a market share of 10 percent

The overall price elasticity of LDV sales was assumed to be –1.0. These elasticities are believed to be on the high side, and this affects the estimated impacts of feebates, as discussed following.

Finally, in order to make the NAFAM a true North American model, a number of assumptions were reviewed or modified in order to properly reflect Canadian and U.S. markets. An important assumption in order to combine data from the United States and Canada is the currency exchange rate. This study assumed an exchange rate of C$1.20 per US$1.00. Table 7-2 shows other country-specific assumptions on fuel price and vehicle operations that were made by the authors of the study.

Nature of Analysis and Major Assumptions

The NAFAM is a static model, and as such, the model results presented in this chapter represent long-run equilibrium solutions 10 to 15 years in the future, when all manufacturers have had the time to retool their facilities in answer to the feebate. The results presented do not consider the transition period between the implementation of the feebate and this end point.

The analysis focused on three feebate rates, which were C$250, C$500, and C$1,000 per L/100 km. These rates were equivalent to US$208, US$417, and US$833 per L/100 km, respectively. Furthermore, the study focused on feebate designs either using a single pivot point or separate pivot points for cars and light trucks. Pivot points, defined in terms of L/100 km fuel consumption, are the boundaries that divide vehicles charged fees from those receiving rebates. By design, the NAFAM also ensured that all feebate cases were revenue neutral by making the fees collected by the government equal to the rebates given. No consideration was given to the administrative cost of the feebate program or to the potential tax revenue loss for the government caused by lower fuel sales.

Fuel consumption rates, consumer's surplus, manufacturers' revenues, and total government transactions were used to measure the impact of the various policies considered. In the case of consumer's surplus, the estimates were based on the assumption that consumers consider only the first three years of fuel savings when buying a vehicle. This is a strong assumption, as there are likely to be fuel savings well after three years. Thus, the analysis of changes in consumer's surplus will tend to overstate the negative impact of policies on the consumers.

The price elasticities used in this analysis are known to be toward the high end of what the published literature will support, and a sensitivity analysis, presented in the next section, showed that the impacts on manufacturers scale almost linearly with price elasticity. For this reason, the analysis probably overestimates the impacts of feebates on manufacturers, and thus these results should be interpreted with caution.

Results

A no-policy scenario was developed in order to estimate the incremental impacts of the various cases considered in this analysis. Consumers are assumed to purchase and manufacturers to implement fuel-saving technologies in the no-policy case up to the point where the marginal cost of the technologies equals the resulting marginal fuel savings. In the following sections of this paper, the impact of all scenarios will be measured by their incremental impacts compared to the no-policy case.

This base case follows Greene et al. by assuming that consumers take into account only the first three years of undiscounted fuel savings when making their purchase decisions. Under this case, a small but significant amount of fuel economy technology is adopted in both countries. The fuel consumption of cars would improve from 7.6 to 7.1 L/100 km in Canada, while the improvement in the United States would be from 8.2 to 7.6 L/100 km. The improvement is relatively more important for light trucks, which see their fuel consumption diminish from 10.7 to 9.8 L/100 km in

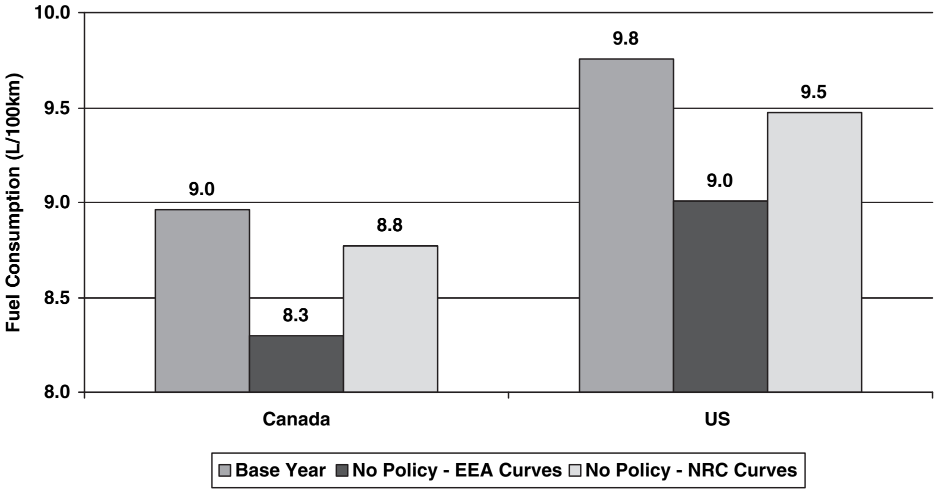

FIGURE 7-2. Effect of updating the fuel economy cost curves on no policy case.

Canada and from 11.4 to 10.4 L/100 km in the United States. Thus, the overall improvement for the new vehicle fleet is 0.7 L/100 km in Canada and 0.8 L/100 km in the United States.

On the other hand, if consumers are assumed to recognize fuel savings over the full life of the vehicle when making their purchase decisions, results are noticeably different. In Canada, passenger car fuel consumption dips down to 6.3 L/100 km, while trucks go down to 8.8 L/100 km, for a fleet average of 7.5 L/100 km. In the United States, the figures are 7.0, 9.5, and 8.3 L/100 km, respectively.

Impact of NRC Fuel Economy Technology Supply/Cost Curves

The base case uses the cost curves developed from the EEA, Inc., 2003 fuel economy technology cost data (EEA, 2005). A separate no-policy case was developed using the average fuel cost and miles per gallon (mpg) cost curves developed by NRC (2002). The results are shown in Figure 7-2. In both countries, the fuel consumption of LDVs decreases less when the NRC curves are used. In fact, the fuel consumption of passenger cars remains constant in both countries, at 7.6 L/100 km in Canada and 8.2 L/100 km in the United States. In the case of light trucks, their fuel consumption goes down to 10.3 L/100 km in Canada from 10.7 L/100 km and 10.8 L/100 km from 11.4 L/100 km in the United States. Those improvements lead to an overall improvement in average fleet fuel consumption of 2 percent in Canada and 3 percent in the United States.

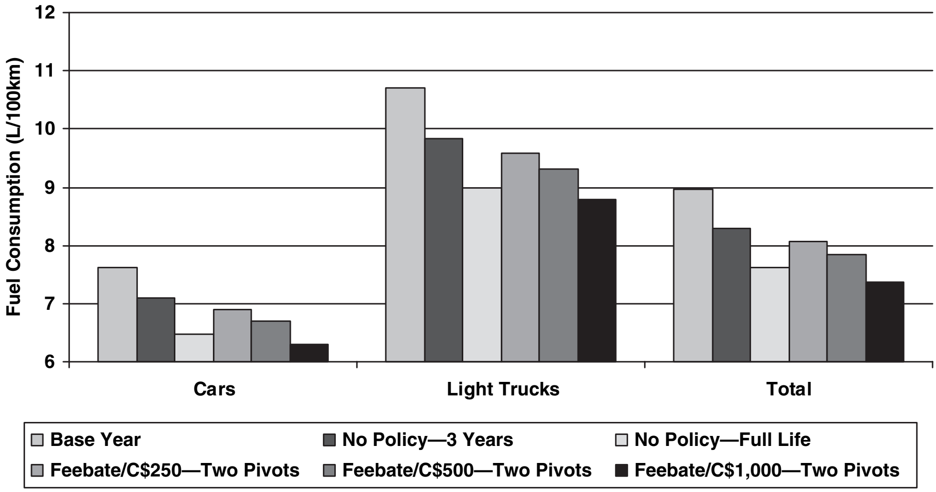

FIGURE 7-3. Impact of two pivot points feebates in Canada—Canada-only policies.

Canada-Only Instruments

The potential impacts of feebate systems implemented only in Canada and not in the United States are of great interest because, as a signatory of the Kyoto protocol, Canada is under obligation to reduce its GHG emissions to 6 percent below their 1990 level. To achieve this goal, many instruments, including economic instruments such as feebates, are being considered. How much can be achieved with different-sized feebates and the impacts on Canadian consumers and manufacturers can be estimated by the NAFAM. To date, the U.S. government is under no such pressure to reduce its GHG emissions, and has not expressed interest in feebates.

Two Pivot Points Instruments

Figure 7-3 shows the results of the various scenarios under two pivot point conditions. Introducing a feebate with a rate of C$250 per L/100 km with two pivot points, one for passenger cars and one for light trucks, in Canada has a small but measurable impact on the Canadian fleet of new vehicles. The fleet average fuel consumption was estimated to decrease from 8.3 to 8.1 L/100 km. Passenger car fuel consumption would decrease by 2.8 percent, while it would decline by 2.7 percent for light trucks. Marginally, consumers were worse off than under the no-policy case, as their net surplus decreases by US$15 million because they are forced into buying more fuel-efficiency technology than they would have wished.

For the Canadian government, the feebate results in total annual transactions of US$363 million. Total government transactions represent the sum of the absolute values of rebates and fees. For Canadian manufacturers, the feebate program leads to a decrease in revenue of US$734 million, or 2.1 percent but not in LDV sales. The fact that revenues decline while sales more or less stay constant is due to consumers buying proportionally smaller, more efficient, and less expensive cars. Because of these market shifts, the major North American manufacturers—Ford, General Motors, and DaimlerChrysler—are even more adversely affected by the feebate system. They see their revenues decline by US$872 million, while the other manufacturers collectively experience an increase in revenues of US$138 million. These results are highly dependent on the price elasticities used to conduct the analysis, and they should be treated with caution.

In the United States, the Canadian-only feebate has a small impact on fuel consumption as the fleet average fuel economy improves by 0.03 L/100 km, the same change as under the no-policy option. The Canada-only feebate also has only a limited impact on other key variables such as consumer's surplus, vehicle sales, and manufacturers' revenues.

Increasing the Canada-only feebate rate to C$500 per L/100 km with two pivot points more than doubles the impact of the feebate on fuel consumption and total government transactions, which increase to US$717 million per year. Under this scenario, the consumer's surplus decreases by US$84 million, because consumers feel more pressure to buy more energy efficient technologies. Manufacturers see their sales decrease by 0.2 percent, but because they sell more lower-priced vehicles, their revenues decrease by 4.1 percent. As a group, the major North American manufacturers face a net fee, which results when the total fees imposed on their vehicle sales are larger than the total rebates received from the sales of eligible vehicles. Other manufacturers are beneficiaries of a net rebate. In the United States, the Canada-only C$500 case has a marginal impact on fuel consumption, sales, and revenues when compared to the no-policy case.

Introducing a feebate with a rate of C$1,000 per L/100 km with two pivot points has roughly the same impact as if consumers considered the full value of fuel savings that can be realized when purchasing more fuel-efficient vehicles. The fleet average fleet economy would improve to 7.4 L/100 km. Passenger car fuel consumption would decrease by 17 percent, while it would decline by 18 percent for light trucks. However, such a feebate rate represents a carbon premium of approximately $175 per metric ton of carbon dioxide if amortized over 200,000 km, which is much higher than other energy consuming sectors of the Canadian economy are currently expected to bear in Canada's efforts to reach its Kyoto target.

Consumers would feel significantly worse off under such a steep feebate rate as their surplus actually decreases by US$388 million because they are induced to buy more fuel-efficient technology than they otherwise would have. In addition, the implementation of a feebate of that scale results in significant transactions, as much as US$1.4 billion a year. For Canadian manufacturers, the feebate program leads to reduced revenues of

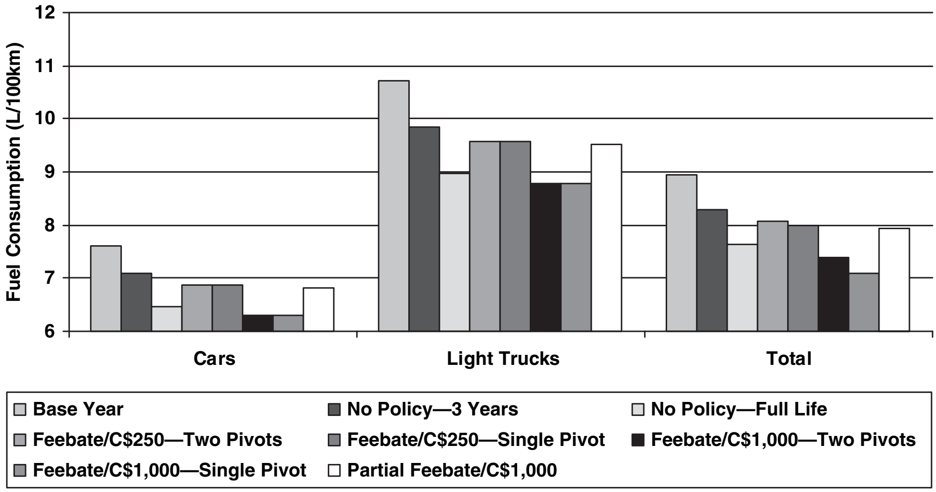

FIGURE 7-4. Impact of single and two pivot points feebates in Canada—Canada-only policies.

US$2.8 billion, or 8.0 percent, and a 1.1 percent drop in sales as consumers turn to more efficient but less expensive vehicles in response to the significant price signals provided by the feebate policy.

In this scenario, the major North American manufacturers are even more adversely affected by the feebate system. They see their revenues decline by US$3.5 billion, while the other manufacturers collectively experience an increase of US$648 million. In the United States, the feebate has a limited impact on fuel consumption. Passenger cars, light trucks, and the fleet average fuel consumption decrease by 0.1 L/100 km. Similarly, the Canada-only feebate has only a limited impact on other key variables such as consumer's surplus, vehicle sales, and revenues.

Single Pivot Points Instruments

Figure 7-4 shows the results of the various scenarios under single point conditions compared to two pivot point conditions. Keeping the feebate rate constant but using only one pivot point for all LDVs has no impact on the technology response that will be observed for each vehicle. For the consumer, a dollar received in the form of a rebate is equal to a dollar avoided in a fee. So manufacturers will put the same amount of technology in the vehicles as long as the feebate rate remains the same, regardless of where the pivot points are set. This explains why the average fuel consumption of cars and light trucks does not change when going from two to one pivot point.

Moving the pivot point will definitively have an impact on the rebate or fee that each vehicle will face, however. The change in the relative price of cars and light trucks explains the great impact that can be observed in the market shares of cars and light trucks when introducing a single pivot point. For instance, the market share of passenger cars increases by 3.3 percent with a rate of C$250 per L/100 km, and by 12.1 percent when the rate increases to C$1,000. These market shifts are responsible for the lower average fleet fuel consumption. The single pivot point also leads to slightly larger total government transactions and to a significantly larger impact on vehicle manufacturers. As in the two pivot points case, the major North American manufacturers are net fee payers, while the other manufacturers receive net rebates. The consumer's surplus, for its part, decreases by US$299 million, almost double the decline when compared to the two pivot points case. As is the case in the other Canada-only scenarios, the impact on the U.S. market is very limited.

One of the practical obstacles to the implementation of a feebate is the large number of transactions that a full feebate system would generate. One way to circumvent this problem would be to implement a "partial feebate," where only the most and least efficient vehicles would be affected. In effect, such a program could be seen as a combination of a gas-guzzler tax and a rebate on highly efficient vehicles. A new scenario was constructed to test the impact of such a program. It analyzed a partial feebate with a common pivot point for cars and light trucks and a rate of C$1,000 per L/100 km.

Under these conditions, LDVs with fuel consumption below 6.0 L/100 km were eligible for a rebate, while vehicles with a fuel consumption above 10.2 L/100 km faced a fee. These levels were chosen to make the partial feebate revenue neutral. Under such a program, the average fuel consumption of the fleet goes down to 7.9 L/100 km, at a relatively small cost—a decrease of US$79 million in consumer's surplus—to consumers. The partial feebate also leads to a significantly smaller loss of revenues for manufacturers, given the high feebate rate, especially for the major North American manufacturers. The partial feebate also limits the amount of total government transactions to US$352 million, the lowest of all the feebate options tested.

Rebates and Fees

The impact of rebate programs, using rates of C$250 and C$1,000 per L/100 km, were also considered. The rebate used two pivot points: for cars and light trucks. Rebates provide incentives for vehicles with fuel consumption below the pivot point but levy no fees on vehicles with higher fuel consumption rates. The pivot points are 6.5 L/100 km for cars and 8.6 L/100 km for light trucks. These pivot points were 25 percent below the current Canadian Company Average Fuel Consumption (CAFC) standards.

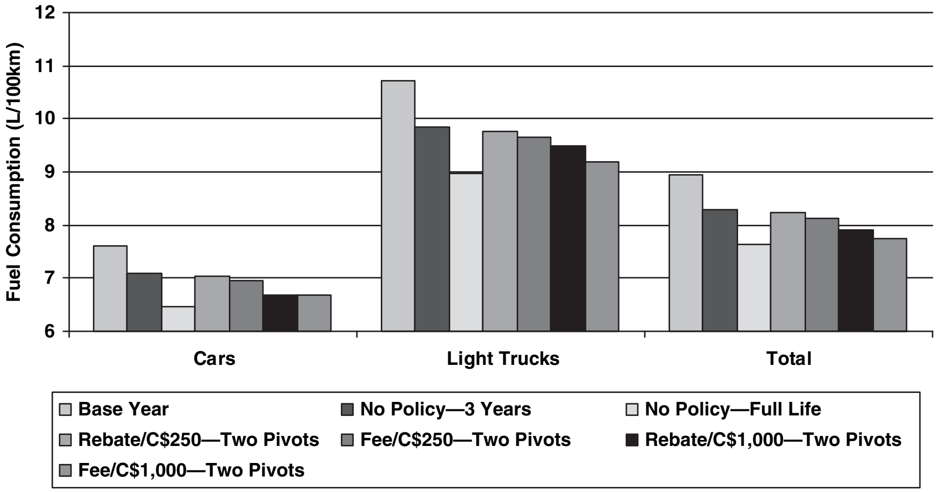

FIGURE 7-5. Impact of rebates and fees in Canada—Canada-only policies.

The results of these analyses are summarized in Figure 7-5. Using these relatively severe pivot points, the C$1,000 rebate system nevertheless results in fuel consumption averages almost as low as they would under the C$500 feebate scenario. The actual values were 6.7 L/100 km for cars and 9.5 L/100 km for light trucks, resulting in a 7.9 L/100 km fleet average.

A C$250 rebate policy would cost significantly less, US$69 million per year in rebates, but would be environmentally ineffective. With a C$250 rebate, sales increase by 0.2 percent, while revenues decrease by 0.1 percent. Only when the rebate rate is quadrupled do consumers move into cheaper, more efficient cars in a significant way as manufacturers see their revenues decrease by 0.6 percent even though sales increase by 1.3 percent. Once again, this program would have a very minor impact on the U.S. market.

If a fee was charged instead of a rebate for each LDV with a fuel consumption above the pivot points used in the rebate case, the resulting fuel consumption improvements would be larger than with the rebate. Of course, the fees would have a large impact on consumer's surplus, which would decrease compared to the no-policy case, and on manufacturers, who would see their revenues decrease.

United States-Only Instruments

The NAFAM analysis next switched to investigating the impacts of feebate scenarios implemented only in the United States. These analyses used two pivot points, for cars and light trucks, and assessed feebate policies that applied either to all of the U.S. market, or alternatively to only 25 percent of it. This proportion represents roughly the population of California and of

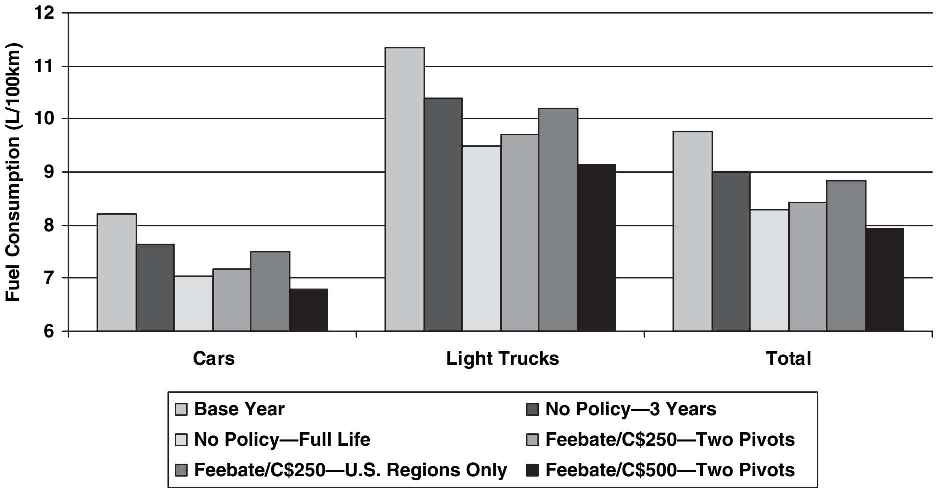

FIGURE 7-6. Impact of two pivot points feebates in the United States—U.S.-only policies.

eight northeastern states, including Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. The results of these analyses are shown in Figure 7-6.

A C$250 feebate was first considered. Passenger cars and light trucks in the United States would see fuel consumption drop to 7.2 and 9.7 L/100 km, respectively, while the fleet average would fall to 8.4 L/100 km. U.S. consumers see their surplus diminish by US$460 million and total government transactions rise to US$3.7 billion per year. The market composition is only marginally affected by the feebate, and sales and revenues decline by 0.3 and 2.0 percent, respectively. The impact of the U.S. feebate policy on the Canadian market is similar to what it would be if Canada implemented a similar feebate in its market but at a smaller cost to Canadians.

Doubling the U.S. feebate rate to C$500 per L/100 km has a significant impact on the fuel consumption of new vehicles. The U.S. fleet average drops to 7.9 L/100 km. This significant improvement in fuel consumption is accompanied by a decline in consumer's surplus, an increase of annual government transactions to almost double what they were with the C$250 feebate rate, and a decrease of manufacturers' vehicle sales and revenues by 0.9 and 4.0 percent, respectively. In Canada, the impact of the U.S.-only policy is significant, dramatically improving fuel consumption. Canadian manufacturers would benefit by seeing their revenue increase by 1.1 percent, mostly because of the increase in vehicle price due to the new fuel-saving technologies being installed in vehicles.

A scenario applying a C$250 feebate to 25 percent of the U.S. market was analyzed to illustrate the effect of a state-level feebate. In this case, there are significant impacts on fuel consumption in the overall U.S.

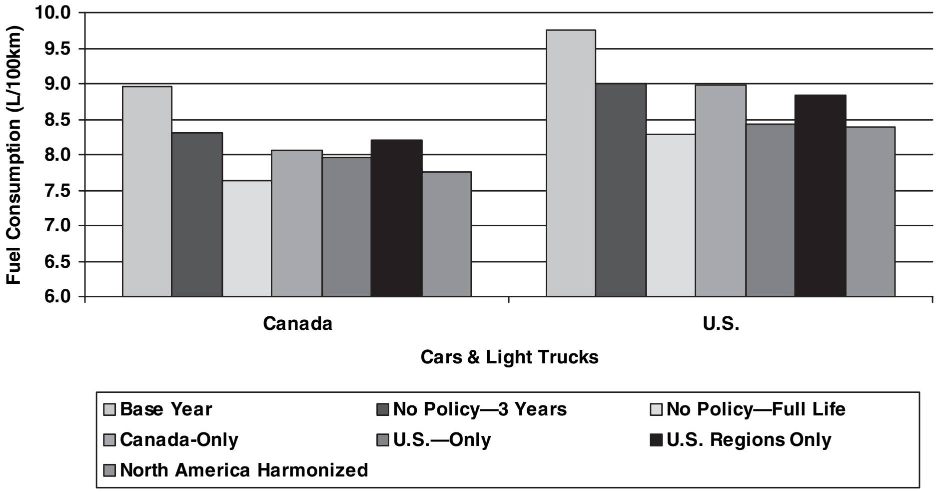

FIGURE 7-7. Impact of a two pivot points C$250 feebate on the average fleet fuel consumption—various market coverage policies.

market. Passenger cars and light trucks see fuel consumption decrease to 7.5 and 10.2 L/100 km, while the average fleet fuel consumption drops to 8.8 L/100 km. Consumers see their surplus decrease by US$119 million, while manufacturers see their sales remain roughly constant, while revenues decrease by 0.5 percent. Total government transactions are also much lower, at US$942 million. The regional feebate also has an impact on the Canadian vehicle fleet, where the average fuel consumption goes down to 8.2 L/100 km, which is only 0.2 L/100 km higher than the result that is achieved if Canada implemented a C$250 feebate on its own. Canadian consumers and manufacturers are also positively affected by the regional U.S. feebate.

North American Instruments

It is clear from the Canada- and U.S.-only scenarios just presented that the United States has a much more important impact on the Canadian market than Canada has on the United States. Figures 7-7 and 7-8 present the effect of various feebate policies on the fleet average fuel consumption for both countries with different market coverage such as Canada-only, U.S.-only, U.S. region-only, and finally a harmonized North American feebate policy. Figure 7-7 represents the impact of a C$250 feebate, while Figure 7-8 represents the impact of a C$500 feebate. Both figures show that the impact on the United States of Canada implementing a feebate on its own is small in all scenarios. Canada, however, would see the fuel consumption of it fleet improve dramatically if the United States implemented a feebate, whether the feebate policy is harmonized or not.

In the NAFAM, the adoption of fuel economy technologies in response to price signals is highly dependent on the fuel economy technology

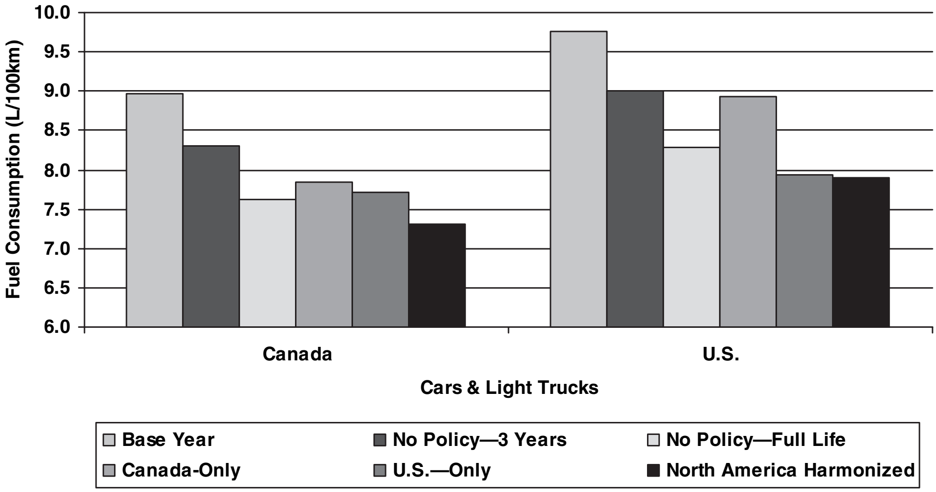

FIGURE 7-8. Impact of a two pivot points C$500 feebate on the average fleet fuel consumption—various market coverage policies.

supply/cost curves. As Canada represents a small proportion of the North American market, adoption of fuel economy technologies is always more important in the United States than in Canada when comparable policies are implemented in each country. Figure 7-9 illustrates the distribution of North American vehicle sales by fuel economy for various policies. Introducing a harmonized North American feebate reduces significantly the number of vehicles consuming more than 10 L/100 km.

Impacts of Changing the Vehicle Price Elasticities

This study used the same vehicle choice elasticities employed by Greene et al., 2000. However, those elasticities were deliberately chosen to be at the upper end of values appearing in the published literature and so might also be high for the Canadian market conditions. For this reason, a few scenarios were run with vehicle choice price elasticities at –5 and –2.5 for choice within a class or among classes, respectively. These elasticities are consistent with results reported by Bordley (1999), for example, for the United States. The overall price elasticity was maintained at –1.0 for all scenarios.

Figure 7-10 illustrates the impact of the alternative elasticities on the average fleet fuel consumption. Clearly, manufacturer revenues are much less affected by feebates when the lower elasticities are used. Revenue losses are roughly half as large. For this reason, the results of our analysis, especially the impacts on manufacturers, should be interpreted with caution because they are strongly dependent on the assumed price elasticities of vehicle choice.

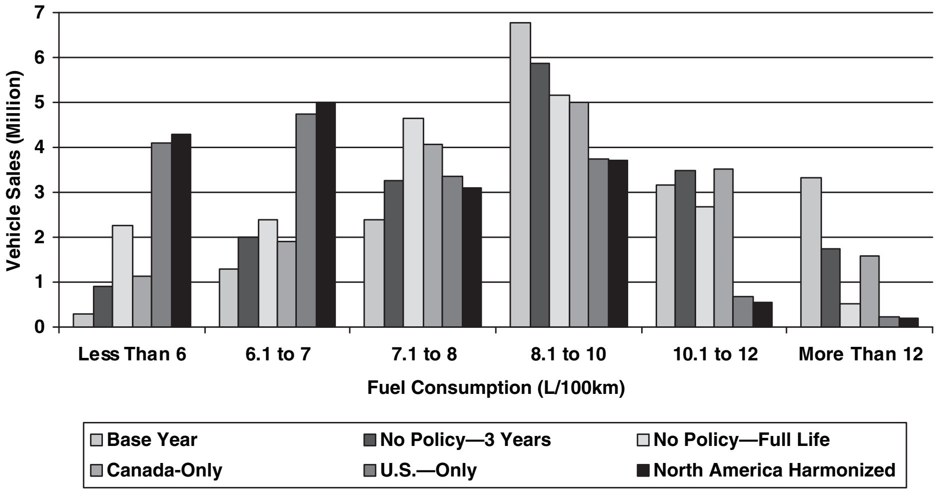

FIGURE 7-9. Effect of two pivot points C$500 feebates on distribution of vehicle sales by fuel consumption in North America—various market coverage policies.

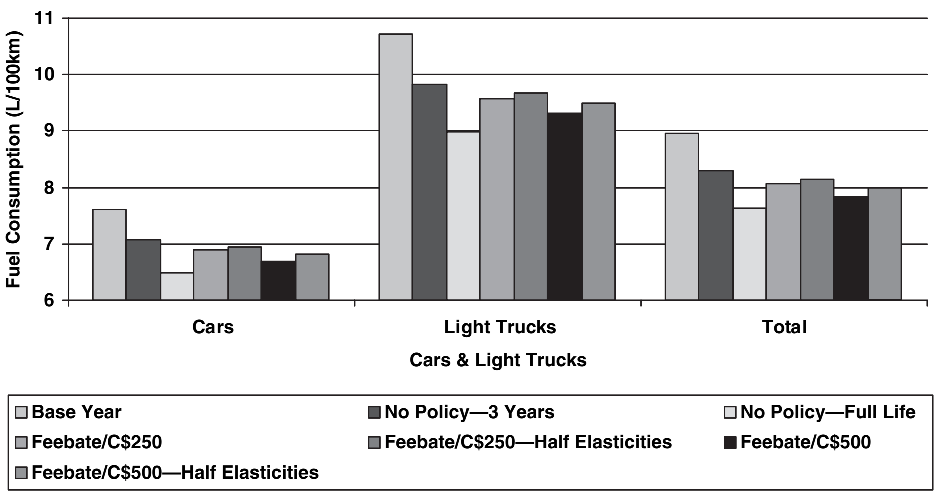

FIGURE 7-10. Impact of halving elasticities on the average fleet fuel consumption.

Conclusion

This chapter has presented the results of an analysis of the impacts of Canada-only, U.S.-only, and harmonized North American feebate policies on the North American vehicle market and on the Canadian and U.S. markets individually. The results presented here are dependent on two key assumptions:

- When modifying vehicles in response to a feebate policy, manufacturers will keep all vehicle characteristics but fuel economy constant
- The results apply to a single year, 10 to 15 years in the future, when all manufacturers have had the time to retool their facilities in answer to the feebate

If Canadian consumers do not fully value the lifetime fuel savings due to fuel economy improvements, then this market failure could be countered almost completely with a Canada-only C$500 feebate with two pivot points. If a North American harmonized feebate were introduced, the same results could be achieved with half this rate. This would result in a much smaller adverse impact on Canadian consumers and vehicle manufacturers.

This study presents for the first time the effect of Canada-only feebate policies as a change in the overall North American market demand for fuel economy. No country has ever implemented a large-scale feebate program. Consequently, some of the effects estimated in this study might be significantly different in a real world situation, thus calling for a cautious implementation of such an economic instrument.

There are still a number of issues related to feebates that would warrant further study, both in terms of data and model improvements. Although there is some evidence that there is a market failure for fuel economy technology in Canada, no research has been conducted to determine the extent to which such a market failure exists. Second, new and used vehicle price elasticities for the Canadian market have not been estimated. Although the fuel economy improvement estimates from the model are not very responsive to changes in the elasticities, the impacts on manufacturers and consumers are highly dependent on the elasticity values used. Third, the fuel economy technology cost curves used in the analysis are class averages and do not include diesel and hybrid electric technologies. Fourth, the solution provided by the model represents a long-run market equilibrium, after manufacturers have modified all their vehicles and fully retooled their plants in reaction to the feebate policy. The costs and benefits, and optimal feebate policy, as well as the impact of the policy on the overall LDV market during the transition, should also be investigated.

Author's Note

The views and opinions of authors expressed in this paper do not reflect those of the Canadian government.

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